

## CLAIMS

---

[Claim(s)]

1. Excitation light bunch (A) with the 1st optic axis ( $k_{\text{ein}}$ ).

A planar waveguide (1).

A sample (80) which interacts with an EBANESENTO place of this planar waveguide.

An output grating coupler (7) for carrying out the wired AND of the portion of luminescence light which can draw inside of a detecting optical path (60) which comes out of the above-mentioned planar waveguide (1) with the 2nd optic axis (61), and/or the above-mentioned waveguide (1).

It is the integrated optical luminescence sensor provided with the above, arranging geometrically the 1st and 2nd optic axis ( $k_{\text{ein}}$ , 61) of the above, and/. or. /using a selectable optical component for the above-mentioned optical path (60) of an output side by polarization -- and. or. /detecting a portion of the above-mentioned luminescence light which comes out of output lattice combination (7) selectable by polarization -- and. or. While serving as output lattice combination of the above-mentioned excitation light, detect the lattice (4) which helps, comes out and also performs coupling of excitation light additionally selectable by polarization, The above-mentioned luminescence light is spatially separated from the above-mentioned excitation light.

2. Excitation light bunch (A) with the 1st optic axis ( $k_{\text{ein}}$ ).

A planar waveguide (1).

A sample (80) which interacts with an EBANESENTO place of this planar waveguide.

A detecting optical path (60) which comes out of the above-mentioned planar waveguide (1) with the 2nd optic axis (61).

It is the integrated optical luminescence sensor provided with the above, Both the above-mentioned optic axes ( $k_{\text{ein}}$ , 61) are curved mutually.

3. Sample (80).

A planar waveguide (1).

An input grating coupler (4).

An excitation light bunch (A) which coupling is carried out within the above-mentioned waveguide (1), forms a light wave (5) drawn, interacts with the above-mentioned sample (80), and generates luminescence light with the above-mentioned input grating coupler (4).

A detection system which detects the above-mentioned luminescence light with a detecting optical path (60, 61,  $k_{aus}$ ) and a detector (11).

It is the integrated optical luminescence sensor provided with the above, A coupling side (3), It is stretched by normal stood to the above-mentioned waveguide (1), and a wave vector of a light wave (5) which is drawn as for the account of the upper, An entrance plane (2), While being stretched by wave vector ( $k_{ein}$ ) of an incoming beam which enters into the above-mentioned waveguide (1), and a light wave (5) which is drawn as for the account of the upper, the above-mentioned coupling side and an entrance plane make a more desirable larger, larger crossing angle [ than 1 degree ] ( $\theta$ ) than an angle of divergence of the above-mentioned excitation light bunch (A).

4. In an optical luminescence sensor by which any one statement of claim 1 thru/or 3 was integrated, a condensing optical system (6, 9) with the above-mentioned detecting optical path (60), An integrated optical luminescence sensor catching a part of above-mentioned luminescence light emitted to the whole space, and leading to a detector (11).

5. In optical luminescence sensor by which any one statement of claim 1 thru/or 4 was integrated, An input grating coupler (4) and an output grating coupler (7) are arranged at the above-mentioned planar waveguide (1), An integrated optical luminescence sensor, wherein a portion of the above-mentioned luminescence light which can draw inside of this waveguide (1) and comes out of the above-mentioned wired-AND lattice (7) is supplied to a detector (11) as a detecting optical path ( $k_{aus}$ ).

6. In optical luminescence sensor by which any one statement of claim 1 thru/or 4 was integrated, An integrated optical luminescence sensor which arranging an input grating coupler (4) at the above-mentioned planar waveguide (1), carrying out the wired AND of the portion of the above-mentioned luminescence light which can draw inside of this waveguide (1) with the above-mentioned input grating coupler (4), and supplying a

detector.

7. Integrated optical luminescence sensor which is characterized by angle between coupling side (2) and entrance plane (3) being smaller than 30 degrees, and being preferably smaller than 15 degrees in integrated optical luminescence sensor according to claim 4.

8. In optical luminescence sensor by which any one statement of claim 1 thru/or 7 was integrated, The above-mentioned excitation light bunch (A) and the above-mentioned detecting optical path (60) are breadth at last in a section, An integrated optical luminescence sensor by which orientation and a probe index in the above-mentioned waveguide (1) are characterized by light from the above-mentioned excitation light bunch (A) not having come to arrive at a field (13) within the above-mentioned detecting optical path (60) by one reflection.

9. In optical luminescence sensor by which any one statement of claim 1 thru/or 8 was integrated, Light (TM wave) which polarized thoroughly so that a magnetic field might become a waveguide boundary and parallel, An integrated optical luminescence sensor which using for excitation of the TM mode which can draw inside of a waveguide, or excitation of the TE mode to which light (TE wave) which polarized thoroughly so that an electric field might become a waveguide boundary and parallel can lead inside of a waveguide.

10. An integrated optical luminescence sensor in order to detect the above-mentioned luminescence light in the integrated optical luminescence sensor according to claim 9, wherein one of polarization of versatility of excitation light is chosen.

11. In an optical luminescence sensor by which claims 1, 5, and 6 or any one statement of ten was integrated, An integrated optical luminescence sensor in order to excite a TE wave which can draw inside of a waveguide, when using excitation light by which TE polarization was carried out, wherein a portion to which TM polarization of the above-mentioned luminescence light was carried out is detected.

12. In an optical luminescence sensor by which claims 1, 5, and 6 or any one statement of ten was integrated, An integrated optical luminescence sensor in order to excite a TM wave which can draw inside of a waveguide, when using excitation light by which TM polarization was carried out, wherein a portion to which TE polarization of the above-mentioned

luminescence light was carried out is detected.

13. An integrated optical luminescence sensor, wherein a sensor plat form consists of a single waveguide field linked to one input grating coupler (4) in an optical luminescence sensor by which claim 1 or any one statement of 9 thru/or 11 was integrated.

14. An integrated optical luminescence sensor, wherein a sensor plat form consists of a single waveguide field linked to one output grating coupler (7) in an optical luminescence sensor by which claim 1 or any one statement of 9 thru/or 11 was integrated.

15. In an optical luminescence sensor by which any one statement of claim 1 thru/or 14 was integrated, An integrated optical luminescence sensor, wherein a sensor plat form consists of a single waveguide field and one output grating coupler (7) linked to one input grating coupler (4).

16. In an optical luminescence sensor by which any one statement of claim 1 thru/or 14 was integrated, An integrated optical luminescence sensor, wherein a sensor plat form consists of a separated waveguide field of plurality which each input grating coupler or each connects with one common input grating coupler (4) in each.

17. In an optical luminescence sensor by which any one statement of claim 1 thru/or 16 was integrated, An integrated optical luminescence sensor, wherein a sensor plat form consists of a separated waveguide field of plurality which each output grating coupler or each connects with one common output grating coupler (7) in each.

18. In an optical luminescence sensor by which any one statement of claim 1 thru/or 17 was integrated, while each connects with each input grating coupler or one common input grating coupler (4), a sensor plat form, An integrated optical luminescence sensor consisting of a separated waveguide field of plurality which each connects with each output grating coupler or one common output lattice combination (7).

---

## DETAILED DESCRIPTION

---

[Detailed Description of the Invention]

Integrated optical luminescence sensor This invention, An excitation light bunch with the 1st optic axis, a planar waveguide, and the sample that

interacts with the EBANESENTO place of this waveguide, It is related with the integrated optical luminescence sensor which makes the example of a changed completely type in the definition of this invention which has a detecting optical path by the generic concept of claim 1 which comes out of the above-mentioned waveguide with the 2nd optic axis, or a luminescence detector by the generic concept of claim 3.

The excitation light bunch in which especially this invention has the 1st optic axis, and a planar waveguide, The sample which interacts with the evanescent field of this waveguide, It has an output grating coupler for carrying out the wired AND of the portion of the luminescence light which can draw the inside of the detecting optical path which comes out of the above-mentioned waveguide with the 2nd optic axis, and/or the above-mentioned waveguide by the generic concept of claim 1, or a luminescence detector by the generic concept of claim 3, The luminescence light which should be detected by a luminescence detector is related with the integrated optical luminescence sensor which dissociating from excitation light spatially.

Since the sensor which detects a substance on the surface is driven conventionally, this kind of sensor is used. In the sensor technology using affinity, the molecule which should be detected is detected by an interaction with the light wave which joins together selectively on the surface of a sensor, and is drawn. In the case of a direct affinity sensor, this phenomenon is performed by measuring change of a refractive index, and the luminescence light excited by the drawn light wave is alternatively detected in that case.

The example which uses a planar waveguide in order to detect the substance which emits luminescence is indicated to the literature Proc.SPIE 1886(1993)2-8 page by Dee Christensen etc. An optical path is die clo IKKU in order to stop catoptric light and the scattered light (from for example, a sensor edge), since it exists in one flat surface. A beam splitter and a marginal filter must be used and there is a fault that a dynamic range and detection sensitivity fall.

Although the parallel waveguide and the sensor which has coupling and/or one or more grating couplers which carry out a wired AND for the light drawn are publicly known at the international application WO 93/No. 01487, it is a direct detecting method by a refractive index change, for example.

A light guide is performed in the optical surface which generally intersects perpendicularly with the surface of a waveguide (getting it blocked and coupling and  $k$  vector of light which carried out the wired AND existing in one optical surface), and it can become \*\* and a fault to use such a device for detection of luminescence. Therefore, in order to separate excitation light and luminescence light and to stop catoptric light and the scattered light, it is die clo IKKU. The measure of forming filters, such as a beam splitter, a diaphragm, interference and a notch, and an edge, is needed also in this case.

Also with the device indicated to the US-A-5,081,012 No. using a grating coupler, combination of excitation light and luminescence light is performed collinear, or an excitation light way and a luminescence optical path exist in one optical surface. In order to separate such an optical portion spatially, the curved grid line must be used, and when it does so, extraordinary expense will start manufacture of a sensor element.

Although it should be considered that this kind of a method and a device are a part of indications of this invention, they are indicated to the international application WO 95/No. 33198.

On the assumption that SUBJECT referred to as that this invention enables little high sensitivity luminescence detection of the noise using an optical plat form with a grating coupler in detection of this luminescence. The spatial segregation of catoptric light, luminescence light, and excitation light is attained by using the polarization characteristic of drawing excitation light and luminescence light or excitation light, and luminescence light.

An aforementioned problem is solved as follows by claim 1. Namely, arranging an optic axis ( $k_{\text{ein}}$ , 61) geometrically in the luminescence sensor by the generic concept of claim 1 and/. Or using a selectable optical component for the optical path (60) of an output side by polarization and/. Or detecting the portion of the luminescence light which comes out of output lattice combination (7) selectable by polarization and/. Or while serving as output lattice combination of excitation light, the luminescence light which entered into the suitable detector is spatially separated from excitation light by detecting the lattice (4) which also performs coupling of excitation light additionally with the help selectable by polarization. The spatial segregation of the luminescence light and excitation light

which enter into a detector can be attained especially by curving both optic axes ( $k_{\text{ein}}$ , 61) of each other by claim 2.

It is [ in / with a publicly known sensor / this "direct" sensor by which symmetrical arrangement judges those with coplanar \*\*, and this always judges a refractive index change highly ] idiomatic and significant.

The solution of claim 3 pulled up the symmetry of the sensor even in the 1st possible ranking, and according to the characteristic portion of claim 4, the entrance plane leans to the plane of union. This angle of gradient of 1 degree - 30 degrees of abbreviation is 2 degrees - 15 degrees more preferably.

It is suitable in the direction of the angle of divergence of excitation light, and the angle of divergence of a detecting optical path.

The further advantageous example of composition is a device given in a corresponding low rank claim.

Claim 4 has described the modification which catches the luminescence light detected in the above-mentioned space without being influenced by a waveguide.

Claim 5 has planned to catch within a waveguide the luminescence light which carried out coupling using output lattice combination.

It is also possible and significant to perform the detecting method of these both simultaneously.

This composition does not have [ as opposed to / especially / small bad alignment and angle variation ] susceptibility. This has a big meaning about exchange of a sensor and the manufacture permissible error of a sensor especially.

The further advantage of the device by this invention is being able to carry out compactly by the module which had the light guide system integrated. the light of the total \*\*\*\* required in this module, in order to use a sensor -- coupling -- and a wired AND is carried out, and it is detected, and gets. That this miniaturization is attained works advantageously, also in order to reduce the inhibitory effect for which it depends on environment, such as an extraneous light and vibration, for example.

Although claim 6 is also related to the prehension of luminescence light which carried out coupling within the waveguide, in order to carry out coupling of the excitation light here, input lattice combination is used. This embodiment became possible by telling the propagation of the

luminescence light which carries out coupling and can draw the inside of a waveguide that there is no preferential direction in a surprising thing. Similarly it is possible to carry out together with one side of the detecting method of previous statement of this detecting method or both. This embodiment can draw not only the coupling of excitation light but the inside of a waveguide, and has the advantage that the same lattice can be used also for the wired AND of the luminescence light detected continuously. Claims 7 and 8 are related to the geometric arrangement with the purpose of lessening disturbance by excitation light as much as possible in the detector for luminescence light of remarkable slant. As for claim 8, the excitation light bunch and the detecting optical path are breadth at last in the section.

The orientation and the probe index in a waveguide are related to the gestalt which may have come to arrive at the arbitrary side within a detecting optical path by reflection with a single light from an excitation light bunch (operation).

The polarization characteristic of excitation light and luminescence light which is mutually different, According to claim 9, the excitation light which polarized thoroughly, i.e., the light which polarized so that a magnetic field might become parallel thoroughly with a waveguide boundary, (TM wave). Excitation of the TM mode which can draw the inside of a waveguide, or when the light (TE wave) which polarized so that an electric field might become parallel thoroughly with a waveguide boundary is used for excitation of the TE mode, respectively, it can use advantageously fundamentally. According to claim 10 in that case, in order to detect luminescence light, it is advantageous to choose one of polarization of the versatility of excitation light.

Since various polarization comes out at an angle of versatility by a wired AND, especially the thing for which polarization detects the portion of the luminescence light which carries out coupling within a waveguide and comes out of output lattice combination selectable is advantageous. By this, it can produce by gap of a spectrum and the luminescence light by which the wired AND was carried out to the excitation light which is outputted at a differing [ mutually ]-as a result angle, and by which the wired AND was carried out can be separated spatially. Since there is no preferential

direction in a surprising thing, it becomes possible for the luminescence light which carried out coupling to come also out of the lattice (4) used for the coupling of excitation light, and to be detected only from output lattice combination (7) with a detector at the propagation in the waveguide of the luminescence light which carried out coupling. When using the excitation light by which TE polarization was carried out, the portion of the luminescence light which carries out coupling within a waveguide, and TM polarization is carried out and comes out of lattice combination is detected, And when using the excitation light by which TM polarization was carried out, coupling is carried out within a waveguide and it is convenient to detect the portion of the luminescence light which TE polarization is carried out and comes out of lattice combination.

Carry out coupling within a waveguide, and if the portion of the electric doublet of a waveguide which comes out from the neighborhood very much is computed, for example with the help of A14 (1994) of Novo Touny and the U.S. Kunimitsu society report, and the formula of what is called helmholtz to which it was stated by 91 pages, It became clear that the luminescence lifetime of electric doublet decreased and the photon up to 3 times per unit time was emitted by an interaction with the evanescent field of a waveguide. In a waveguide, I hear that coupling of this additional photon is carried out, and the end product of this calculation has it. The portion of the luminescence light which carried out coupling within the waveguide can be 3 times the light intensity emitted to all the solid angles from the electric doublet which is not blocked in this way.

A 1st embodiment supports this knowledge.

When using the excitation light to which TE polarization of this invention was carried out, carry out coupling within a waveguide and the further desirable embodiment of detecting the portion of the luminescence light which TM polarization is carried out and comes out of lattice combination, It consists of a single waveguide field linked to an input grating coupler (4), an output grating coupler (7), or these both grating couplers. As for the sensor plat form by this invention, it is preferred to consist of two or more separated waveguide fields.

In the device of this invention, luminescence light is spatially separated from excitation light in a detector.

Although the device by this invention is explained in detail by the drawing,

a drawing only shows an only concrete embodiment. A drawing should not be referred to in order to limit this invention. For example, a possibility that the polarization explained previously will detect luminescence light selectable, And it is a portion of this invention to divert to a sensor plat form with two or more waveguide fields where the integrated optical luminescence sensor by this invention was separated, although not explained by combination with the embodiment drawn on the drawing or the drawing, either.

Drawing 1 is a figure of the device of this invention with the detector of volume luminescence.

Drawing 2 is the sectional view which cut the conventional luminescence waveguide sensor which has a KOPURENA optical path and has a detector of volume luminescence at xz flat surface.

Drawing 3 is a figure of the modification with "back combination" of drawing 2.

Drawing 4 a is the sectional view which cut the device by drawing 1 at xz flat surface.

Drawing 4 b is the sectional view which cut drawing 1 and the device by drawing 4 a at yz flat surface.

Drawing 5 is a sectional view of the device corresponding to drawing 1 which has a diaphragm in a coupling side.

Drawing 6 is a figure of the device by this invention with the detector of the luminescence which carried out coupling within the waveguide.

Drawing 7 is the sectional view which cut the device corresponding to drawing 6 in respect of coupling.

drawing 8 has a waveguide detector -- an entrance plane, a coupling side, and a detecting direction -- coplanar \*\*\*\*\* (it corresponds to drawing 1 of the international application WO 95/No. 33189) -- it is the sectional view which cut the publicly known device at xz flat surface.

Drawing 9 a is the sectional view which cut the device by drawing 6 at xz flat surface.

Drawing 9 b is the sectional view which cut drawing 9 a at yz flat surface. The example of drawing 1 and drawing 6 shows the method by which it differed for detecting the calculation of luminescence light.

Drawing 1 shows detection of volume luminescence. That is, the portion of the luminescence light excited by incident light is emitted to the whole

space, and it is caught by the condensing optical system (embracing the solid angle caught by this optical system), and it deals in it according to it.

Drawing 6 shows the detection of luminescence by which coupling was carried out within the waveguide. Coupling of the luminescence light is complementarily carried out selectively as a wave which can draw the inside of a waveguide to this luminescence light emitted to space, and it spreads the inside of this waveguide. Here, an output grating coupler can be used for detection, and this coupler can have the same or different lattice cycle while dissociating from a coupling machine spatially. In the further desirable geometrical shape, a wired-AND lattice can also be made the same as that of a coupling lattice.

The liquid cell for supplying a sample is not shown by drawing 1 and drawing 6.

In order to choose one from above-mentioned both method and device, application must be chosen especially (desirable) in consideration of the following thing. Namely, the bond length of the molecule fixed to the waveguide surface, distance, the mode (it is dependent on refractive-index and thickness) refractive value of the light which can draw the inside of a waveguide, Attenuation of the waveguide in the wavelength of excitation light and luminescence light, the surface of a sensor and geometry, the sample body product on a sensor, and the flowing state in a sample cell must be taken into consideration. Both the above-mentioned methods are also combinable.

When drawing 1 detects volume fluorescence, the light (5) with the wavelength of incident light drawn is excited by the input grating coupler (4) within a sensor face (1). Most is caught by the condensing optical system (6) of the lower part of a sensor face although the luminescence of the sample excited by the evanescent field of the light (5) drawn in a border area with a waveguide (1) is emitted to all the solid angles. An entrance plane (2) is stretched by  $k$  vector of incident light ( $k_{\text{ein}}$ ) and the light (5) drawn, and a coupling side (3) is stretched by the normal of a sensor face (1), and the light (5) drawn.

$\theta$  is a crossing angle of an entrance plane (2) and a coupling side (3). Incidence out of the coupling side (3) of excitation light is accompanied by the result that  $k$  vector ( $k_{\text{ein}}$ ) of incident light exists in a different

entrance plane (2) from a coupling side (3). The further spatial segregation by different propagation can be attained by using "back combination" from which the direction of x ingredient of k vector ( $k_{\text{ein}}$ ) of incident light and the direction of the light which can draw the inside of a waveguide (1) differ. It originates in entering light by this, for example to a sample cell and the dirt of the mechanical unit near the sensor and dullness, and the transparent part ( $k_{\text{trans}}$ ) and reflection part ( $k_{\text{ref}}$ ) of incident light etc., The optical portion of excitation light can be certainly prevented from reaching a luminescence detector directly by an easy measure. These measures are completely effective, also when the geometry of coupling deviates from a desired value slightly.

That the advantage by a coupling side differing from a wired-AND side should be explained, when the above-mentioned measure is given up that is, the problem produced in the detecting method of the conventional volume fluorescence is made to state in detail below.

The optical path in such a case is shown in drawing 2, and the excitation light A enters in the  $k_{\text{ein}}$  direction in xz side which is a plane of union. Drawing 1 is complemented and the liquid cell (8) with the sample (80) of the sensor face (1) upper part, and a detector (11) and the opening of the condensing optical system (6) which has a detecting optical path (60) with an optic axis (61) are shown. "A front combination" is shown as coupling. The coupling angle ( $\alpha$ ) between k vector ( $k_{\text{ein}}$ ) of incident light and the normal of a sensor is chosen as the size that the optical portion reflected by the sensor cannot reach a detector (11) directly through the opening of a condensing optical system (6). In order to explain concretely, the case ( $k_{\text{ein1}}$ ,  $k_{\text{ref1}}$  which are shown as a solid line) where a coupling angle ( $\alpha$ ) is too small, and the case ( $k_{\text{ein2}}$ ,  $k_{\text{ref2}}$  which are shown with a dashed line) where it was large enough were shown in drawing 2. Since a required minimum input bond angle ( $\alpha$ ) is decided by the opening of a condensing optical system (6), the condensing optical system with strong luminous intensity needs the large opening coupling angle from which it separates far from the altitude stood to the sensor face.

With this large coupling angle, carrying out the optical module for driving a waveguide sensor structurally requires expense compared with structural operation of a module version with the coupling angle near the altitude of a sensor.

In a coupling angle ( $\alpha$ ) large enough, the reflected excitation light ( $k_{ref}$ ) enters into a detector (11) by one reflection with a wall (13). For example, in order to control the scattered light by the Sumiya dirt which surface (13) of a wall Goes away, also when a publicly known measure was taken, there was a possibility that the disturbance light which has an adverse effect on a detector (11) by this might occur. In the conventional luminescence detection, in order to separate luminescence light and excitation light, the marginal filter or the band pass filter has been used. When these filters are predetermined interception rates, in the excitation light of a prescribed wavelength, the level of disturbance light restricts the resolution of a measuring method.

Replacing with drawing 2, drawing 3 shows the optical path which avoided the above-mentioned problem by carrying out "back combination" of the excitation light drawn. Although the coupling angle  $\alpha$  which exceeds 30 degrees also in this case is avoided, the coupling which pierces through a condensing optical system (6) as an example is further shown by drawing 3. Especially this composition serves as a fault for luminescence detection of high sensitivity. That is, disturbance light may arise near the detector (11) by dispersion of the light in the surface of the optical component used especially a mirror (14), and a condensing optical system (6).

Moreover, disturbance light may enter into (11) in a similar manner by one reflection with a wall (13). Drawing 4 a is the section cut at xz flat surface, and it is shown, respectively what kind of influence the composition with the entrance plane (2) which drawing 4 b is the section cut at yz flat surface, and inclined to the coupling side (3) of drawing 1 has on a disturbance signal. As the vector shown with the dashed line shows, in xz sectional view and yz sectional view, it is important that k vector is shown by projection to each section. "Backward coupling" (back combination) is chosen as coupling, and excitation light may pass the side of a lens (3) by leaning an entrance plane to xz flat surface of a graphic display. I hear that an angle required for important one to pass the side of a lens (6) as compared with drawing 2 and the composition of 3 when the opening of a lens (6) is the same is smaller in xz flat surface and yz flat surface, and there is.

That is, as for  $\tan \alpha$ , in the case of  $\alpha = 0$ , k vector of the "total \*\*\* is \*\* in xz flat surface, for example.

る」場合に比して係数 $\sqrt{2}$ だけ小さくなる。

However, the influence of the leaning entrance plane (3) to the action of the reflected optical portion is decisive. That is, in order to enter a detecting optical path (60) and to lead the light from the excitation light (A) which has an optic axis on the wave vector ( $k_{\text{ein}}$ ) in a figure by leaning an entrance plane to the field of a detector (11) within this optical path, at least two reflective processes are needed. Contrary to this, this effect already arises by one reflection with a wall with drawing 2 and the KOPURENA composition by 3.

Therefore, in drawing 4 a and drawing 4 b, two portions (13a, 13b) of a wall are shown, the cut above-mentioned wall is a solid line, and the thing in xz flat surface of a drawing and yz flat surface is shown by the dashed line, respectively. When the number of reflective processes required in order to lead disturbance light to (11) increases in this way, the efficiency of the measure of the total \*\*\*\* which controls the disturbance light resulting from entering the dullness, dirt, or light of a field is improved remarkably.

The influence of the reflection in the wall (13) or sensor (1), and liquid cell (8) of an optical system is theoretically avoidable by using the angle of gradient which is not equal to 90 degrees in the case of the shape determination of a member, and positioning. However, it depends for control of a disturbance signal on the geometrical shape of excitation and a wired AND in detail. A slight change of a design of a sensor brings about change of the total \*\*\*\* of hardware. Priority should be clearly given over the universal possible design of the liquid cell (8) and the selected system to using the leaning structural element and the optical surface (2, 3) to which this embodiment with an interface inclined.

certainly discriminating from a luminescence signal and a direct optical portion spatially enabling little luminescence detection of noise, and setting to a detection system by it -- for example, a single photon -- the premise for using the detection art of high sensitivity, such as calculation, is made.

The further measure for controlling the extraneous light produced by the disturbance portion of excitation light is shown in drawing 5. Drawing 5 shows the section in the coupling side of drawing 1 (it corresponds to

drawing 4 a). Without excitation light ( $k_{\text{ein}}$ ) piercing through the condensing optical system (9) which collects luminescence lights by choosing the crossing angle theta of an entrance plane (2) and a coupling side (3), passing the side of the flat surface which is separated spatially and is in (9) of a graphic display, and going into an input grating coupler (4) is secured, and it gets. The luminescence light excited in the field of the light (5) drawn is extracted in this intermediate image plane by carrying out image formation to an intermediate image plane first according to a condensing optical system (9), and (10) intercepts the light from the field of a sensor surface. The scattered light from the field of the input grating coupler (4) caused by the peculiar luminescence of the substrate of the lower part of the large surface roughness of the waveguide (1) in the field constituted, for example or a waveguide (not shown in drawing 5) (1) by this is intercepted before a detector (11), and it deals in it. The geometry of the optic axis (61) of a detecting optical path (60) and the whole detecting optical path is become final and conclusive very correctly.

The composition of the luminescence detector at the time of using a waveguide for detection is shown in drawing 6. The coupling of the excitation light (A) which has an axis of symmetry, a wave vector ( $k_{\text{ein}}$ ), and propagation of the light wave (5) drawn is similar with the volume luminescence detector shown in drawing 1. In this waveguide detection, it differs in that the wired AND of the luminescence light which carried out coupling again within the waveguide (1) is carried out by the output grating coupler (7) spatially separated from the input grating coupler (4). This output grating coupler (7) is realizable by changing a grating constant with an input grating coupler (4). The output ( $k_{\text{aus}}$ ,  $k_{\text{aus}}$ ) bond angle of the luminescence light which carried out coupling to the coupling light spread through a waveguide within the waveguide is shown by beta and beta', respectively. This angle beta and beta' are different by the Stokes shift between excitation light and luminescence light, and distribution of output lattice combination (7). Therefore, both are separated geometrically. About the luminescence detection by waveguide detection, the device of drawing 7 is again shown as a sectional view cut in respect of coupling (3). By drawing 7, in addition to a measure as stated above, it extracts near the undersurface of a sensor for detection without noise, and the

further measure using (12) is shown. By the peculiar luminescence of the substrate material which has a waveguide (1) caused by this, for example (not shown in drawing 7), and the luminescence of the molecule in the liquid volumes above the sample field excited by the light (5) drawn. The disturbance light which may be produced to the field (5) to which the excitation light between an input grating coupler (4) and an output grating coupler (7) is led is reduced.

About the case where this waveguide detects luminescence, the advantage by a coupling side (3) differing from a wired-AND side (2) is described by comparing the embodiment of drawing 9 a by this invention, and drawing 9 b with the conventional example of drawing 8. The sectional view which cut the coupling by "back combination" in respect of coupling (xz flat surface) is shown by drawing 8.

The light flux ( $k_{\text{ein}}$ ) which entered is supplied to a waveguide (1) via a mirror (14). Since the interval of a mirror (14) and a detector (11a, 11b) cannot but become large according to both being farther [ than the length of a waveguide (1) ] large, the geometrical dimensions of this mirror (14) should care about the point of barring the miniaturization of a sensor (1) and an optical apparatus. a mirror (14) is deleted -- then, a detector (11a, 11b) -- if excitation light must be supplied and it does so from a lower part far, the miniaturization of an optical apparatus and compact operation will be barred again.

Unlike the case where volume luminescence is detected, in the above-mentioned light guide line detection, the reflected excitation light arrives at the field of a detector (11) by one reflection in the usual component of a sensor. However, in order to lead the reflected excitation light to a detector (11), when the entrance plane (2) leans to the coupling side (3), reflection with more at least one than the case where the entrance plane does not lean as well as the case of volume luminescence detection is needed.

Although the example of the leaning entrance plane (2) and coupling side (3) for the waveguide luminescence detection by this invention is shown in drawing 9 a and drawing 9 b, About wave vector  $k_{\text{ein}}$ ,  $k_{\text{ref}}$ ,  $k_{\text{aus}}$ , and  $k'_{\text{aus}}$ , each projection to xz flat surface of drawing 9 (dashed line which shows vector shows like) a, and yz flat surface of drawing 9 b is shown. The mirror (14) or turn system for excitation light  $k_{\text{ein}}$  can be located out of a coupling

side (3) so that any shadows may not be produced by an optical element in connection with light inclining. Drawing 9 b which is the sectional view cut at yz flat surface, The optical portion (excitation light ( $k_{\text{ein}}$ ), catoptric light ( $k_{\text{ref}}$ ), excitation light ( $k_{\text{aus}}$ ) that carried out the wired AND, luminescence light which carried out the wired AND ( $k'_{\text{aus}}$ )) of the total \*\*\*\* shows that it dissociates spatially by leaning. Whenever the wired-AND angle (beta) which carries out a wired AND to the coupling angle (alpha) into which excitation light enters again differs in the lattice cycle of a coupling lattice (4) and a wired-AND lattice (7), they differ. This can be said about the case where it is related in practice [ the total \*\*\*\* ], through the geometrical shape of various combination (excitation by "back combination", the wired AND by "front combination", etc.).

The geometrical shape with the leaning coupling side (3) and an entrance plane (2) of the above-mentioned total \*\*\*\*, When these both flat surfaces (2, 3) lean, spatial segregation of the optical signal which involves is realized and this spatial segregation is common in the point of reducing remarkably the expense which the measure which discriminates from these optical portions takes.

A sensor can set caudad arrangement of the optical element of the total \*\*\*\* for driving a sensor, it can be performed, and when this drives this sensor in an automatic analyzer, it is advantageous. That is, supply of a sensor, a sample, and a fluid is performed from the upper part.

On the other hand, measurement is performed from a lower part.

The optical element of the total \*\*\*\* which drives a sensor is realizable as a small compact module of an outer size method. Namely, the optical element for forming light as a light source and the mechanical element for justifying a coupling angle by rotating or moving this optical element, for example, Diodes, such as laser, luminescence, superluminescence, etc. which have a light guide for the wired-AND light to emit and a formation system, and an attached detection system, can be used. The above-mentioned detection system can be united with the surroundings of a reference way as a measuring instrument which measures the luminous intensity which carried out coupling.

When choosing the excitation light source and a laser light source with the size clearly exceeding the size of the integrated module must be adopted,

a laser beam is supplied to the module integrated via the waveguide of an embodiment with preferred receiving polarization.

The embodiment described in the example of this invention is convenient. Example 1 Fluorescence which coupling is carried out and can draw the inside of a waveguide A green HeNe laser (made by wavelength 543 nm;MellesGriot) light, Coupling is carried out to a waveguide (waveguide : 150nm TiO<sub>2</sub>; substrate : glass) via the prism of rutile (TiO<sub>2</sub>), and the coloring matter solution (Rhodamin 6G, 10<sup>-6</sup>M) which exists in the form of a drop on a waveguide is excited via an evanescent field. The detection system which consists of the condenser (made by Spindler & Hoyer) of 50 nm, two 550-nm marginal lenses, and an Si-PIN photodiode (made by UDT) arranged by a transducer separating 5 cm caudad catches fluorescence. First, the fluorescence which the signal emitted by the predetermined solid angle carries out coupling subsequently to a waveguide, and comes out of an output grating coupler (lattice cycle: 400 nm) is detected, respectively. As for the optical signal emitted from output lattice combination according to the dispersion property of lattice combination at the angle which changes with excitation light, only 50% is stronger than the optical portion which is emitted by the above-mentioned solid angle and measured with the same detector.

Example 2 the improvement of the S/N ratio using rectangular light polarizer: Fluorescence of the TE wave which coupling is carried out and can draw the inside of a light guide line The HeNe laser (made by wavelength [ of 633 nm ];1 mW;Melles Griot) light by which linear polarization was carried out, Coupling is carried out to a waveguide (waveguide : 150nm TiO<sub>2</sub>; substrate : Corningglas C7059) via a grating coupler, and via an evanescent field, The polymer matrix deposited on the abbreviated 50-nm thickness from which coloring matter (Chiba-Farbstoff WA 3010 and 10<sup>-9</sup>M) is uniformly distributed over an inside is excited. By a delay board ( $\lambda/2=633\text{nm}$ ;Rocky Mountains Instr.) and light polarizer (made by Spindler & Hoyer), coupling of TE polarization or the excitation light by which TM polarization was carried out is carried out selectively. The detection system which consists of an analyzer, a notch filter (made by Kaiser), and a CCD camera (made by Kappa) arranged by a transducer separating 10 cm caudad catches the fluorescence which carries out coupling within a waveguide and comes out of output lattice combination (lattice

cycle: 320 nm). The signal strength of the excitation light which polarized in both the above-mentioned modes is measured also with a rectangular analyzer or a parallel analysis machine. the ratio of both the fluorescence ingredient that will come out of an output grating coupler if coupling of the light by which TE polarization was carried out is carried out -- TE/TM is set to 7:1.

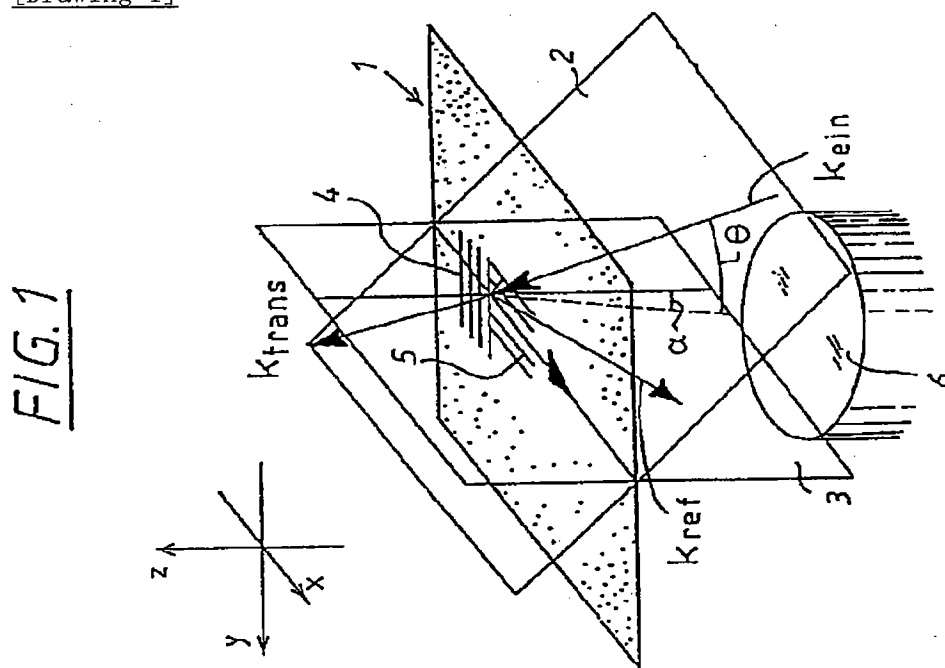
the ratio of both the fluorescence ingredient that will come out of an output grating coupler if coupling of the light by which TM polarization was carried out is carried out -- TE/TM is set to 2.5:1.

---

## DRAWINGS

---

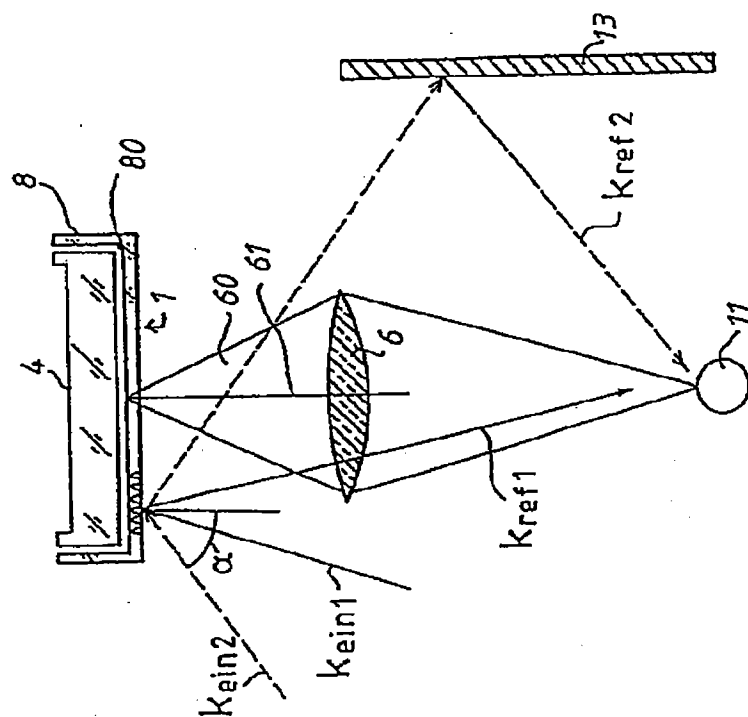
[Drawing 1]



[Drawing 2]

FIG. 2

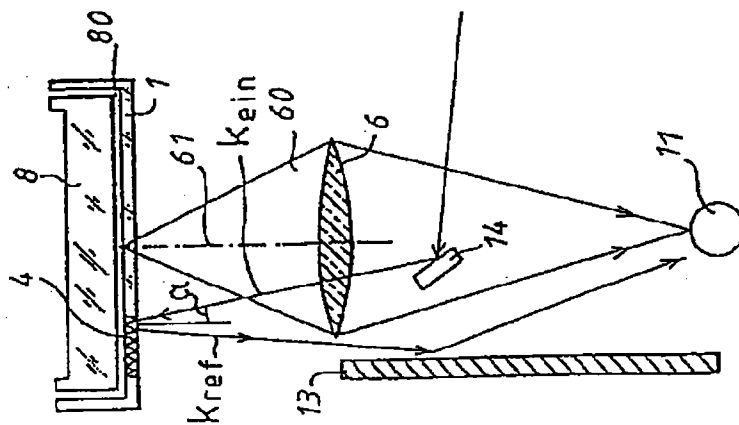
従来例



[Drawing 3]

FIG. 3

従来例



[Drawing 4]

FIG. 4b

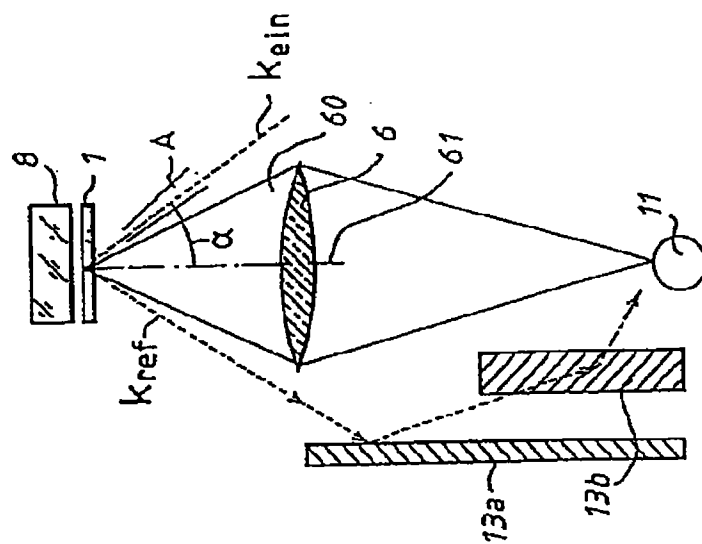
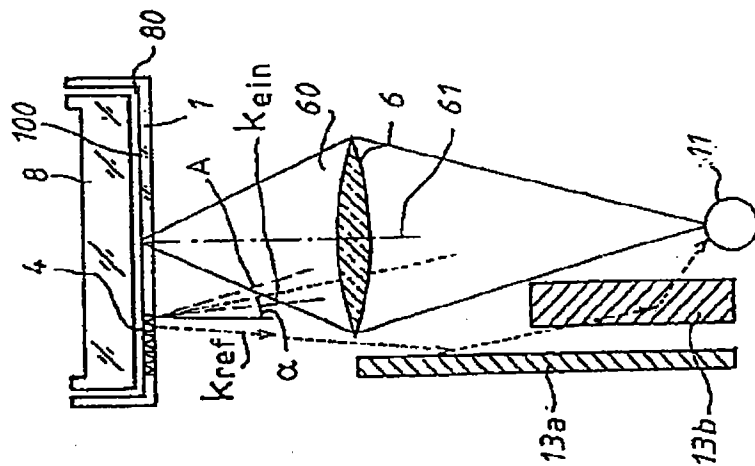
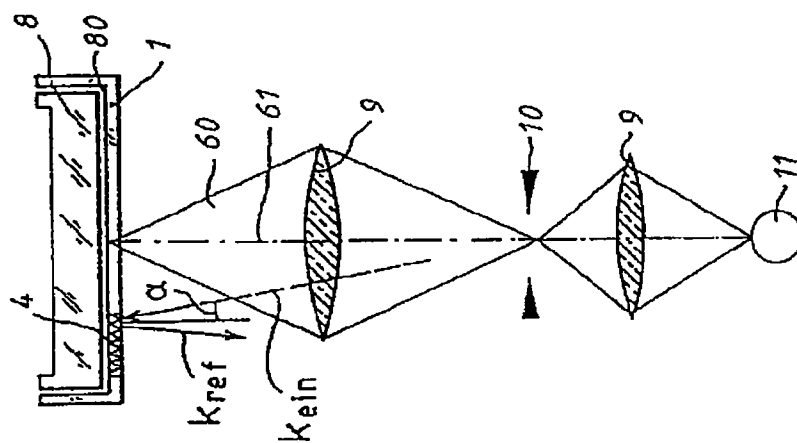


FIG. 4a



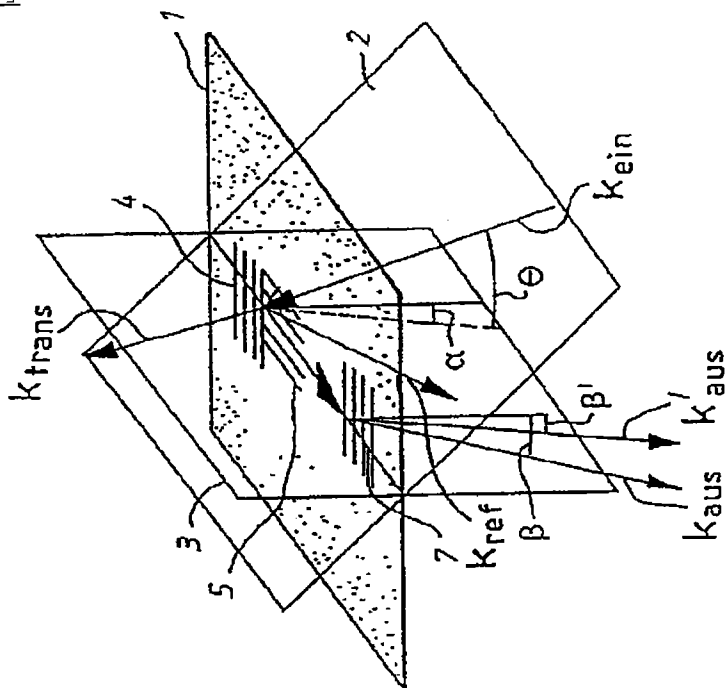
[Drawing 5]

FIG. 5



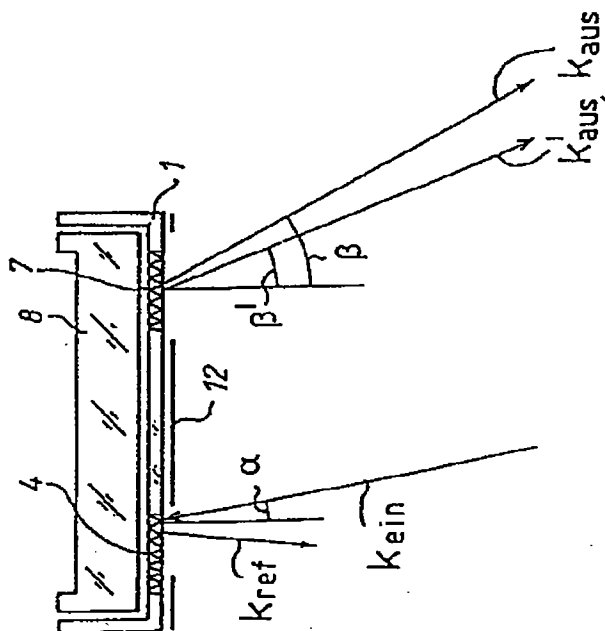
[Drawing 6]

FIG. 6



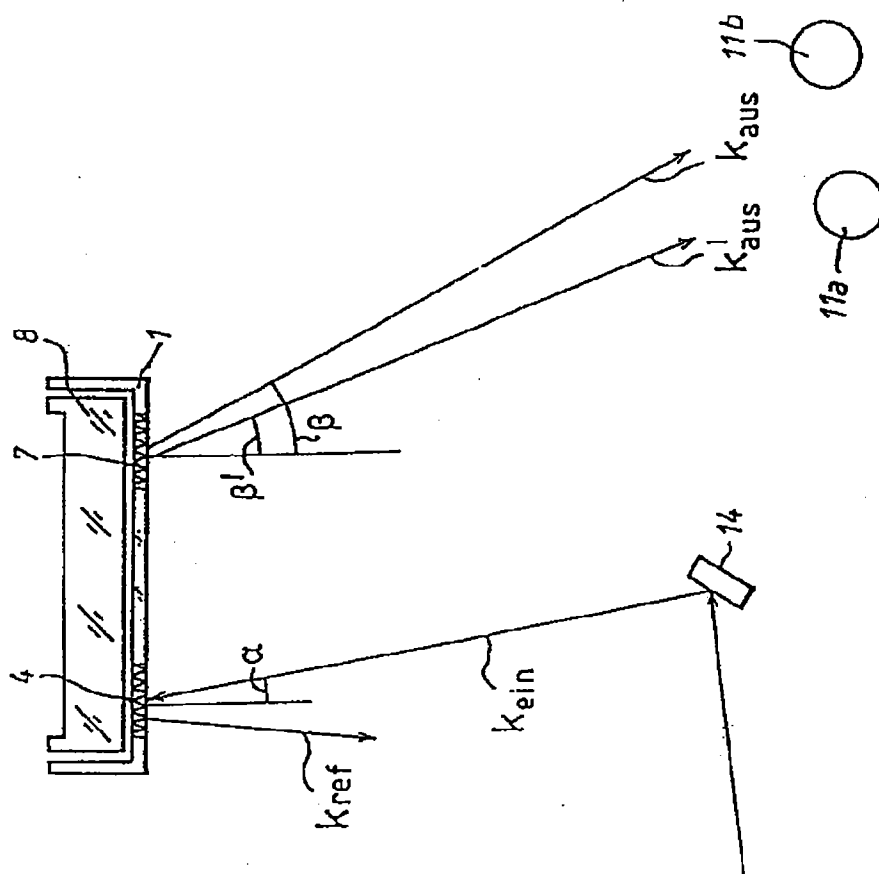
[Drawing 7]

FIG. 7



[Drawing 8]

FIG. 8  
従来例



[Drawing 9]

FIG. 9a

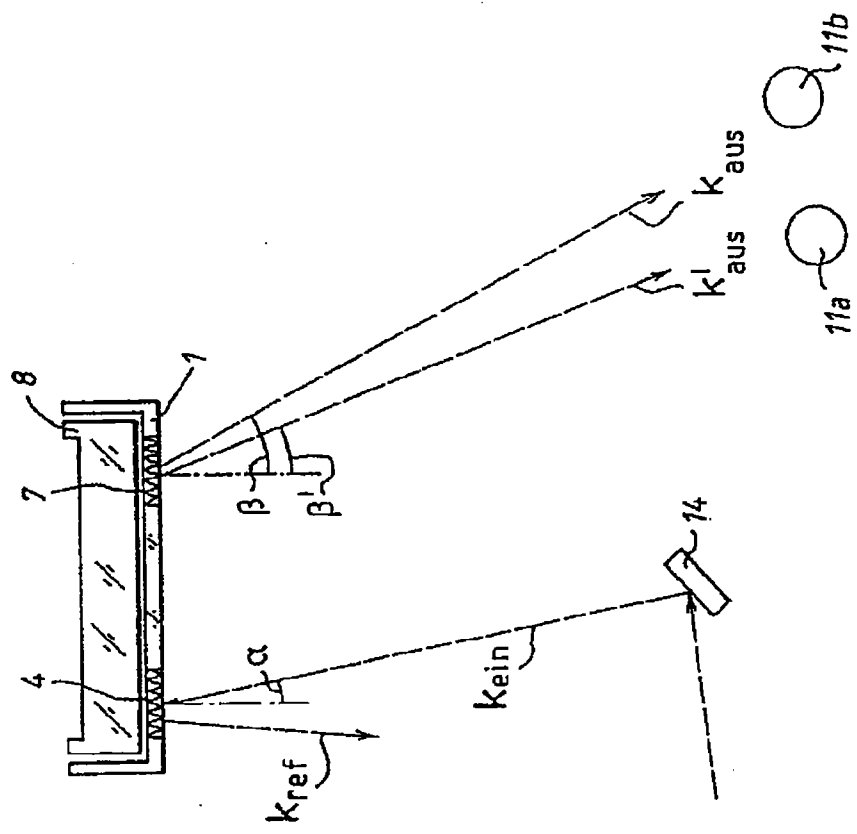


FIG. 9b

